FOREIGN MATERIAL IN SPRING WHEAT.

How to Remove it on the Farm and at the Country Elevator.

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CONTENTS.

FOREIGN MATERIAL DEFINED.

FOREIGN MATERIAL in wheat includes all material other than the thrashed wheat kernels. Weed seeds, cereal grains other than wheat, and pieces of wheat stems and chaff are examples of the foreign material found in wheat. The amount and character of the foreign material vary in the different wheat sections of the country in the same year, and in the same section in different years.

Weed seeds are the most objectionable and usually form the greater bulk of the foreign material in wheat. More than 200 kinds of weed seeds have been found in spring wheat, but less than 20 of these occur commonly. In 1920 representative samples of spring wheat were obtained from approximately 500 shipping points located in the spring-wheat area of the central Northwest. The 18 kinds of foreign seeds or grains most commonly found in these wheat samples, named in the order of their frequency, were wild oats, wild buckwheat, cultivated oats, mustard, lamb's-quarter, barley, green foxtail, hare's-ear mustard, flax, rye, cow cockle, pigweed, yellow foxtail, sunflower, corn cockle, wild rose, king-head, and wild pea (vetch).[1] Repre-

[1] As the common name for these weeds vary in different localities their botanical names are here given:

Wild oats	*Avena fatua.*	Rye	*Secale cereale.*
Wild buckwheat	*Polygonum convolvulus.*	Cow cockle	*Vaccaria pyramidata.*
Tame oats	*Avena sativa.*	Pigweed	*Amaranthus retroflexus.*
Mustard	*Sinapis arvensis.*	Yellow foxtail	*Chaetochloa lutescens.*
Lamb's-quarter	*Chenopodium album.*	Sunflower	*Helianthus annuus.*
Barley	*Hordeum sativum.*	Corn cockle	*Agrostemma githago.*
Green foxtail	*Chaetochloa viridis.*	Wild rose	*Rosa sp.*
Hare's-ear mustard	*Conringia orientaiis.*	French weed	*Thlaspi arvense.*
Flax	*Linum usitatissimum.*	Wild pea	*Vicia Angustifolia.*
		King-head	*Ambrosia trifida.*

sentative kernels of 20 kinds of foreign seeds are illustrated in Figure 1. Wild oats occurred most frequently. It appeared in 99.2 per cent of these samples. The wild-oats infested area extends approximately from the middle of Wisconsin, west to the middle of Montana, and from the northern third of Iowa north to the Canadian

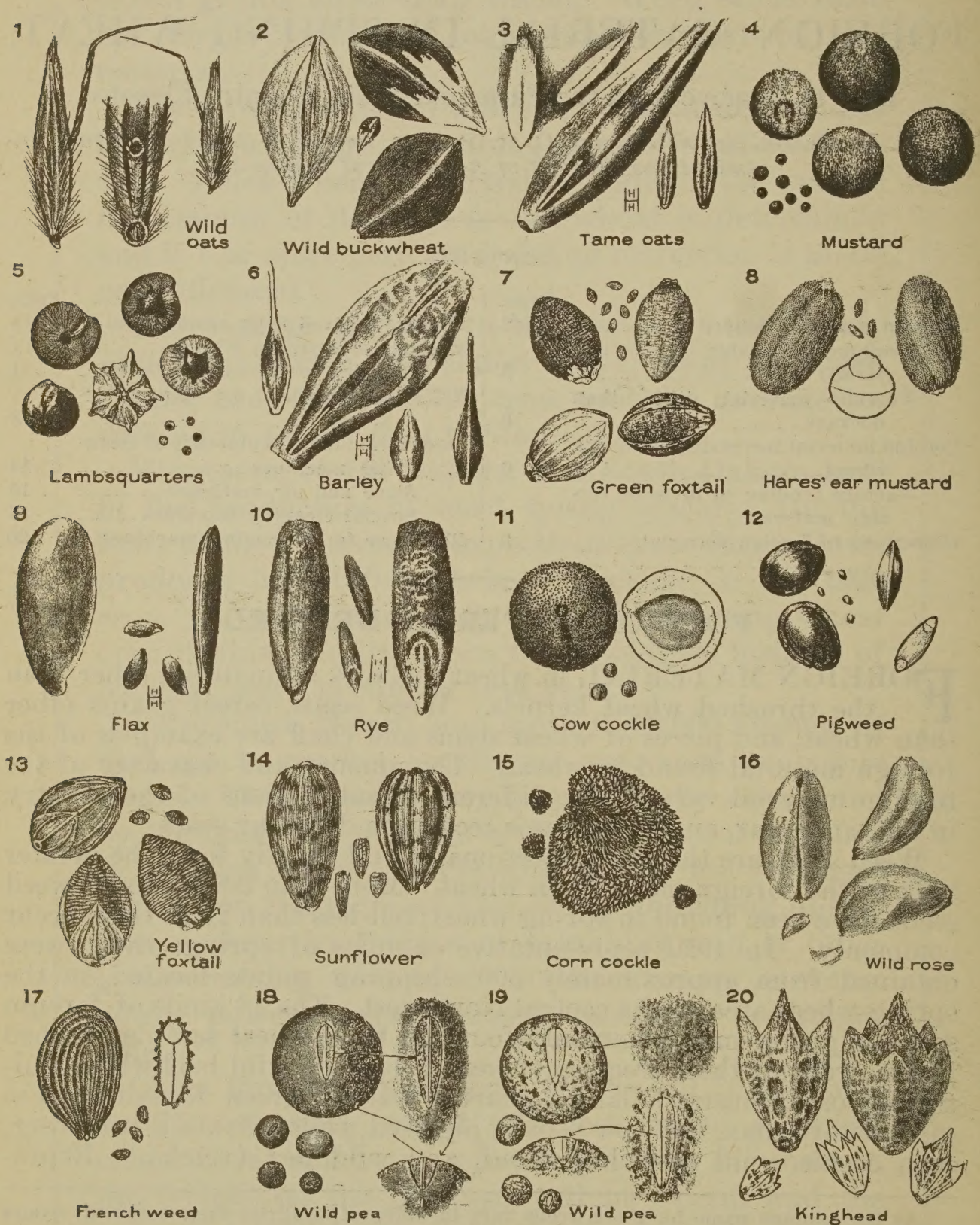

FIG. 1.—Representative seeds of 20 kinds of weeds and grains commonly found in spring wheat.

line. Wild oats are most prevalent in the Red River Valley, covering approximately the western half of Minnesota, the eastern third of North Dakota, and the eastern quarter of South Dakota. The

wild-oats infested area and the area where the infestation is most prevalent are shown in Figure 2.

The nature or character of the foreign material found in wheat from a commercial standpoint may be divided into two classes. These classes are designated in the United States grades for wheat as "dockage" (separable foreign material) and "foreign material other than dockage."

DOCKAGE (SEPARABLE FOREIGN MATERIAL).

Dockage is the term applied to separable foreign material when the wheat is offered for sale on the market. Dockage is defined in

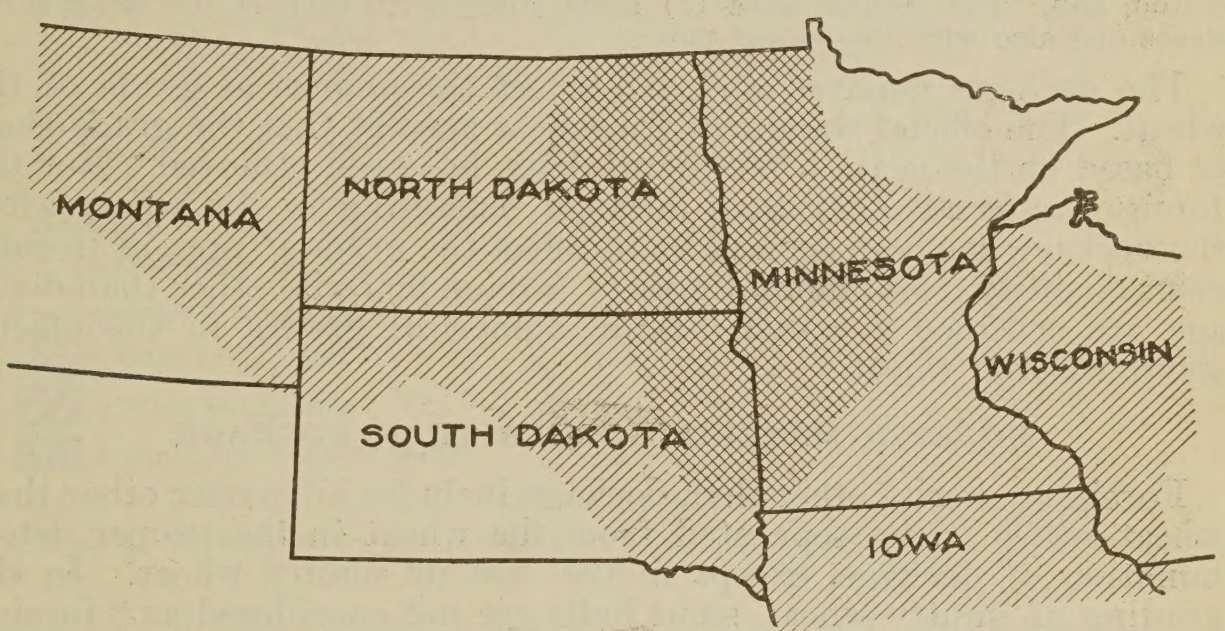

FIG. 2.—Outline map showing the distribution of wild oats in the spring-wheat area of the Central Northwest. The dark shaded portion represents the area of greatest infestation.

the Official Grain Standards of the United States for wheat, effective July 15, 1919, as follows:

> Dockage includes sand, dirt, weed seeds, weed stems, chaff, straw, grain other than wheat, and any other foreign material which can be removed readily from the wheat by the use of appropriate sieves, cleaning devices, or other practical means suited to separate the foreign material present; also undeveloped, shriveled, and small pieces of wheat kernels removed in properly separating the foreign material, and which can not be removed by properly rescreening or recleaning. The quantity of dockage shall be calculated in terms of percentage, based on the total weight of the grain including the dockage. The percentage of dockage so calculated, when equal to 1 per cent or more, shall be stated in terms of whole per cent, and when less than 1 per cent shall not be stated. A fraction of a per cent shall be disregarded. The percentage of dockage so determined and stated shall be added to the grade designation.

EQUIPMENT FOR DETERMINING THE DOCKAGE.

The equipment used in the offices of Federal Grain Supervision in connection with the grading of wheat consists of cleaning devices as follows:

1. A device, popularly designated as the "wild oat kicker," for removing barley, oats, wild oats, pieces of straw, weed stems, and other coarse matter from wheat.
2. Set of perforated metal hand sieves consisting of—

(*a*) Bottom pan; inside diameter, 13⅛ inches; depth, 2½ inches; and roll at top of pan three-sixteenths inch in diameter.

(*b*) Buckwheat sieve, with triangular perforations eight sixty-fourths inch on each side of perforations; inside diameter of sieve, 13 inches; depth of sieve, 2 inches; and roll at top of sieve, one-fourth inch in diameter.

(*c*) Fine seed sieve, with round perforations one-twelfth inch in diameter. (Other specifications and dimensions same as for (*b*) buckwheat sieve above.)

(*c*) Fine seed sieve, with round perforations one-twelfth inch in diameter. eighths inch long. (Other specifications and dimensions same as for (*b*) buckwheat sieve above.)

(*e*) Coarse chess sieve, with slotted perforations 0.070 inch wide by one-half inch long. (Other specifications and dimensions same as for (*b*) buckwheat sieve above.)

(*f*) Scalper sieve, with round perforations twelve sixty-fourths inch in diameter, depth of sieve 1½ inches; inside diameter, 12⅞ inches; and roll at top of sieve, five-sixteenths inch in diameter.

NOTE—*Sieves* (*b*), (*c*), (*d*), and (*e*) are made to nest very freely with the bottom pan. The scalper sieve (*f*) nests freely with each of the other three sieves and also with the bottom pan.

The dockage removed does not affect the numerical grade of the wheat. The official standards for wheat specify that the grade shall be based on the grain after the dockage has been removed. But the foreign material other than dockage remaining in the wheat after the dockage has been removed will affect the grade if present in sufficient quantity. Maximum limits of foreign material other than dockage are specified for each of the numerical grades in the official standards for wheat.

FOREIGN MATERIAL OTHER THAN DOCKAGE.

Foreign material other than dockage includes all matter other than wheat which is not separated from the wheat in the proper determination of dockage, except in the case of smutty wheat. In the grading of smutty wheat, smut balls are not considered as "foreign material other than dockage."

FOREIGN MATERIAL INCREASING IN SPRING WHEAT.

Spring wheat is grown to some extent throughout the northern half of the United States, but the main crop is produced in five States. These States, named in order of production, are North Dakota, South Dakota, Minnesota, Montana, and Washington. Most of the wheat produced in Minnesota and the Dakotas is marketed in Minnesota. The total spring-wheat area in the United States and the areas of heaviest production are shown graphically in Figure 3.

The records of the Minnesota State Grain Inspection Department for the 18-year period from 1903 to 1920, inclusive, tend to show that the percentage of dockage in the wheat arriving at the terminal markets in that State is gradually increasing. These records show that for the crop of 1903 the average dockage was 2.2 per cent; for the 6-year period ending 1908, it was 2.7 per cent; for the next 6-year period ending 1914, it was 2.9 per cent; for the third 6-year period ending 1920, it was 4 per cent; and for the 1920 crop the average dockage was 4.6 per cent. On this basis the 1920 wheat crop ending August 31, 1921, produced in Minnesota, North Dakota, and South Dakota contained over 5,607,054 bushels of dockage. If it may be assumed that 4.6 per cent dockage is a fair average for the total spring-wheat crop in the United States for 1920 it means that over 9,500,000 bushels of 60 pounds each of dockage was thrashed with the wheat that year.

In other words, there was approximately 1 bushel of dockage in every 22 bushels of spring wheat thrashed. If this dockage had been cleaned out of the wheat and then shipped separately to market, it

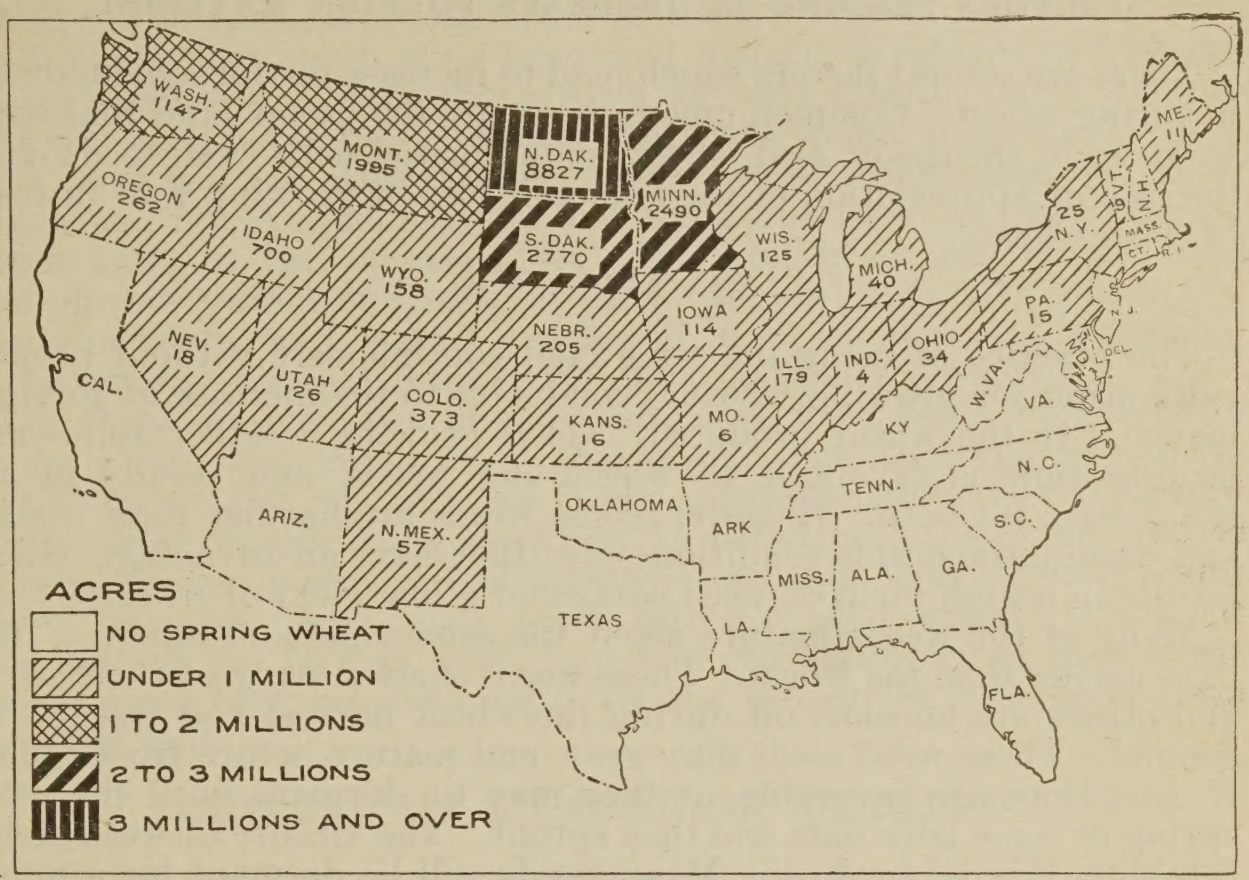

FIG. 3.—Map showing the total spring-wheat area in the United States. Figures shown in States represent thousands of acres in 1921.

would have filled over 14,200 freight cars, each containing 40,000 pounds.

The average dockage for the 6-year periods from 1903 to 1920, inclusive, is shown in Figure 4. The figures shown in the illustration,

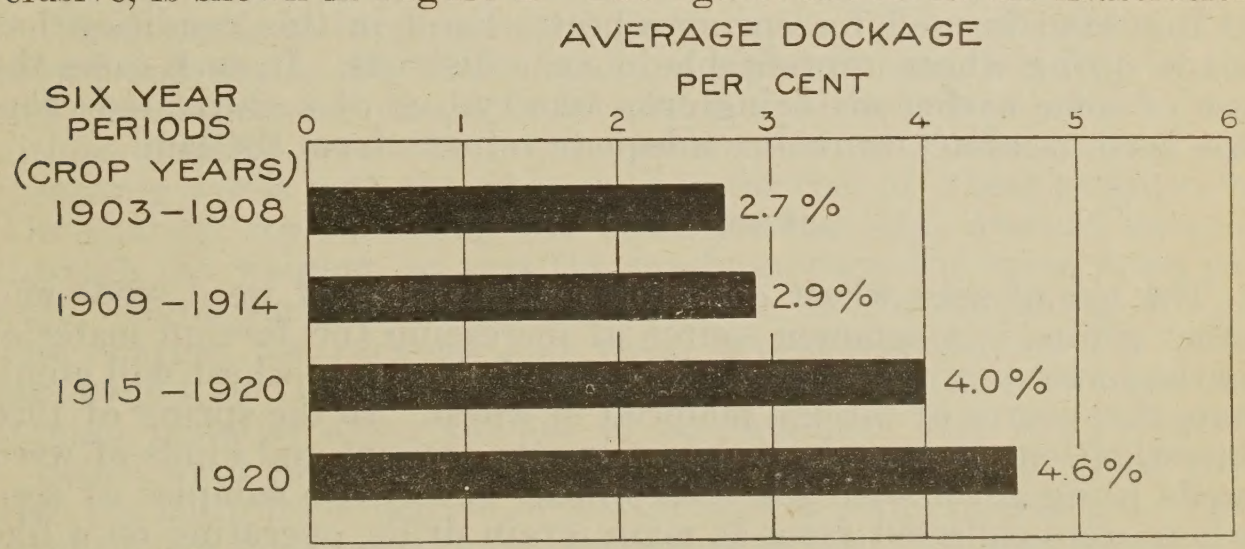

FIG. 4.—Diagram showing the average dockage in spring wheat "on arrival" from September 1, 1903, to August 31, 1921, inclusive, as reported by the Minnesota State Grain Inspection Department.

however, represent only the amount of dockage contained in the wheat at the time of inspection at the terminal markets.

To determine the total amount of foreign material thrashed with the wheat, the dockage removed on the farms and at country elevators would have to be added to that assessed on the wheat shipped to

the inspection points. The amount thus removed no doubt was considerable.

FACTORS TENDING TO INCREASE FOREIGN MATERIAL.

There are several factors which tend to increase the foreign material in spring wheat. Common among these are the use of land foul with weed seeds, the use of seed wheat contaminated with weed seeds, and the lack of appreciation of the economic loss in growing foul instead of clean wheat.

FOUL WHEAT LAND.

The practice of using the same land continuously without proper cultivation for growing wheat is conducive to the increase of foreign material in the wheat produced. Good growing weather following seeding time is favorable to wheat and weeds, and results in an equal start for both. However, some weeds are hardier than wheat, and when unfavorable conditions exist they have an advantage which results in a high yield of weed seeds and a low yield of wheat.

Many of the weeds mature about the same time and others a few days earlier than the wheat. These weeds shatter many of their seeds and others are knocked off during the wheat harvest and fall to the ground. These weed seeds may grow and mature before frost comes if conditions are favorable, or they may lie dormant until the next spring or some later date and then sprout. The vitality of weed seeds is seldom injured by frost. Many weeds will lie dormant for a number of years when buried deeply in the ground and then grow if conditions are made favorable.[2]

Unless the crop of weeds which grows after wheat harvest is destroyed before it goes to seed a large number of weed seeds will be present in the soil the following spring. Under such conditions a large amount of foreign material is likely to be found in the wheat if this land is used for spring wheat. Land in this condition has made spring wheat unprofitable in some districts. In such cases the use of some earlier-maturing crop like rye, or of a cultivated crop, has been necessary to realize adequate returns from the land.

UNCLEAN SEED WHEAT.

The use of seed wheat containing admixtures of weed seeds and other grains is a common source of increasing the foreign material in the succeeding wheat crop. The use of clean seed wheat will eliminate this source of foreign material in wheat. In the spring of 1920 investigations were made to determine the amount and kinds of weed seeds being sown with the seed wheat. Fifty-five samples of seed wheat were collected from as many grain drills, operating on a like number of farms located in the main spring-wheat areas of Minnesota, North Dakota, and South Dakota. The analyses of these samples show that only the wheat being sown on two of these farms was free from weed seeds, and that the seed wheat being sown on the remaining 53 farms contained weed seeds ranging by weight from 0.1 to 17.6 per cent, averaging over 2 per cent. Expressed in numbers,

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[2] From Bureau of Plant Industry Bulletin 83: The Vitality of Buried Seeds, by J. W. T. Duvel.

an average of approximately 53,000 weed seeds per acre were being sown with the seed wheat on these 53 farms.

The five kinds of weed seeds most commonly found in these samples of seed wheat, named in the order of their frequency, were wild oats, wild buckwheat, vetch, king-head, and foxtail. Wild oats were found in 43 samples and were being sown at rates ranging from 2,000 to 283,000 seeds per acre; wild buckwheat was found in 31 samples and was being sown at rates ranging from 6,000 to 155,000 seeds per acre; vetch was found in 26 samples and was being sown at rates ranging from 2,000 to 124,000 seeds per acre; king-head was found in 16 samples and was being sown at rates ranging from 21,000 to 51,000 seeds per acre; and foxtail was found in 15 samples and was being sown at rates ranging from 12,000 to 60,000 seeds per acre.

In these samples, two or more kinds of weed seeds were usually present and often the seeds of other grains, especially rye, were present. On 10.9 per cent of these farms approximately 100,000 foreign seeds per acre were being sown; on 3.6 per cent of the farms 300,000 foreign seeds per acre were being sown; and on 1 farm 489,000 foreign seeds per acre were being sown with the seed wheat. Fully 90 per cent of the foreign seeds found in these samples of seed wheat would have been removed easily by the proper use of a good farm fanning mill.

OBJECTIONS TO FOREIGN MATERIAL.

Foreign material in wheat is objectionable because it is an economic waste which affects both the farmer and the country elevator. It tends to reduce the yield of wheat and to increase the cost of harvesting and thrashing. Foreign material occupies valuable space in wagons and freight cars, in country and terminal elevators, and in flour mills, and it may have a bad effect on the keeping qualities of the grain in storage.

When weeds in large numbers grow in the field with wheat, they crowd and shade the wheat, and use moisture and fertility in the soil that otherwise would be available for the wheat. Such conditions usually result in lower yields of wheat. Harvesting and thrashing weeds with the wheat add to the cost of wheat production. The charges for thrashing are based on the total amount passing through the weigher, so that the producer pays the same price per unit weight for thrashing foreign seeds as for thrashing wheat. The charges for railroad and vessel transportation are the same per pound for foreign material as for wheat. These charges for foreign material alone amount to an enormous sum every year.

Small weed seeds and other fine material mixed with wheat prevent the natural circulation of air through it while in storage. This condition in some cases causes the wheat to heat. Wheat containing a high percentage of foreign material when stored does not flow evenly when drawn from the bin. The last wheat flowing from the bin usually contains more foreign material than the first, or than the average for the entire bin. This condition may cause unevenly loaded cars, and may cause the assessment of an excess of dockage which would result in a reduced price for the wheat.

Many of the weed seeds found in wheat, such as corn cockle, king-head, and wild vetch, have a bad effect on the milling and baking

results when ground with the wheat. The injurious effects on the milling yields and baking qualities of the flour from wheat containing different amounts of corn cockle are shown graphically in Figure 5.

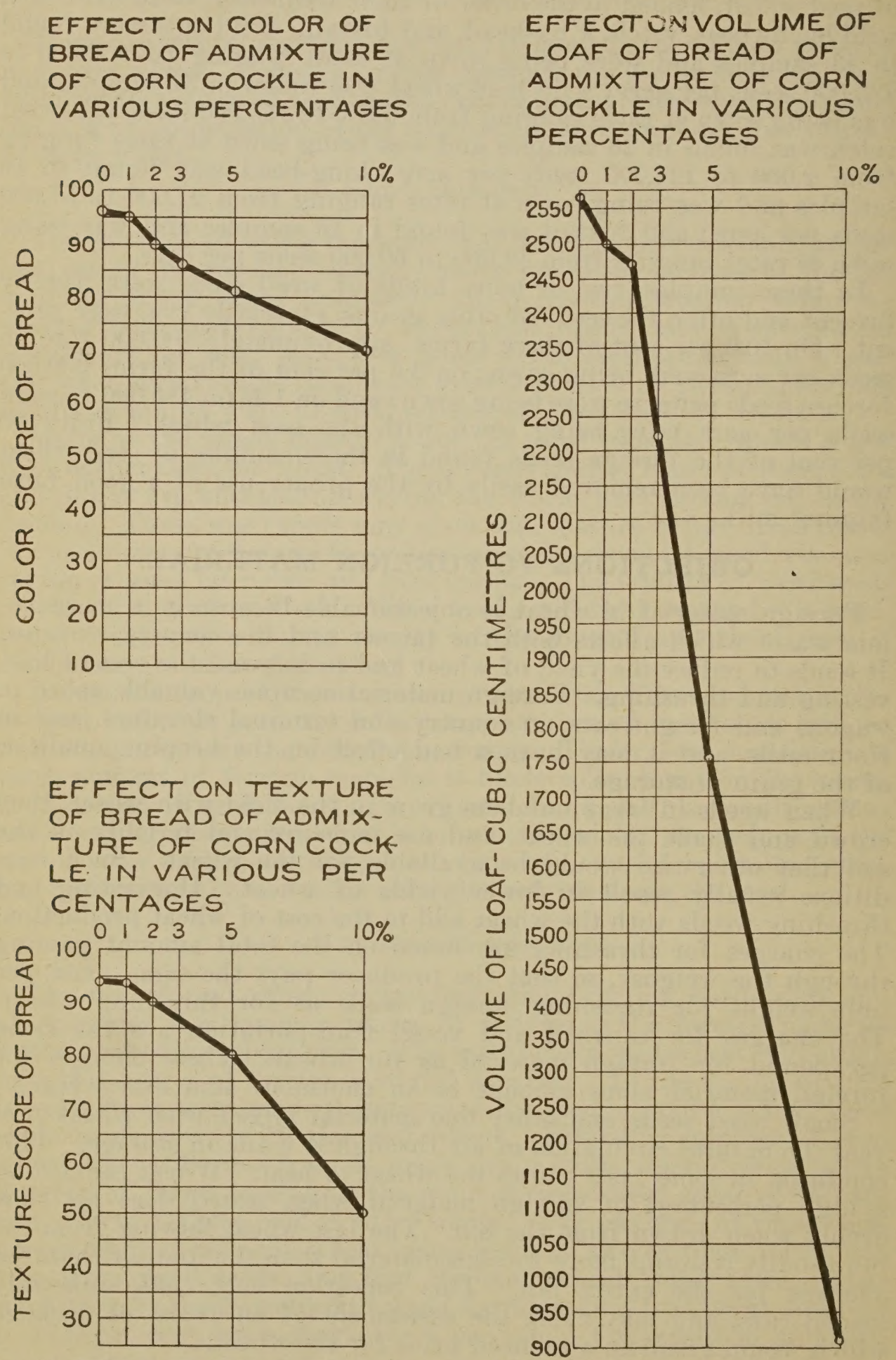

FIG. 5.—Effect on the baking qualities of flour made from wheat containing various percentages of corn cockle.

Weed seeds having strong odors, like sweet clover and garlic, impart their odors to the wheat. Such odors are commercially objectionable and cause the price of the wheat to be heavily discounted, although the wheat may be otherwise of excellent quality.

BENEFITS DERIVED FROM CLEAN WHEAT.

The benefits derived from clean wheat are shared by the farmer and the country elevator. If the farmer cleans his wheat before delivering it to the elevator he saves the cost of hauling the dockage to market, and he may be able to use it to advantage for feed, and make a saving in his feed bill. In many cases these savings will repay the farmer for the time and trouble required to clean his wheat. The contention as to the amount of dockage in the wheat which frequently arises between the farmer and the elevator operator will be avoided if clean wheat is delivered. The price paid for clean wheat at the elevator is usually more per bushel than the price paid for unclean wheat, because the elevator operator must consider either the cost of removing the dockage or the freight charges on it to the terminal market.

Clean seed wheat combined with good farm practice will produce clean wheat. This is being demonstrated constantly on many farms located in the spring-wheat district. In 1920 one township in North Dakota produced more than 30 carloads of hard red spring wheat containing on the average less than 1 per cent of foreign material. No dockage was assessed against this wheat when it was sold. The wheat lands in this township are controlled largely by one farming company. This company cleans thoroughly all wheat used for seed and keeps the land free from weeds. The same year wheat raised in adjoining townships contained an average of more than 7 per cent dockage, and on individual wagonloads the dockage was as high as 20 per cent. One township was so badly infested with corn cockle that for years the grade of the wheat was lowered on that account. The farmers finally adopted the practice of cleaning their seed wheat, which resulted in practically eliminating foreign material from the 1920 wheat crop in that township. In the neighboring townships where the use of clean seed wheat is not practiced a high percentage of corn cockle and other foreign material still exists.

METHODS OF CLEANING WHEAT.

There are two methods of cleaning wheat in common practice. One method uses sieves and air blasts for separating the foreign material from the wheat, and the other method separates the grain according to the size and shape of the kernels. The former method is used in the general-purpose cleaning machines, such as fanning mills and receiving separators, and the latter method is used in machines designed to make special separations, such as cockle cylinders, ring graders, and disk machines.

CLEANING WHEAT ON THE FARM.

The farm is the logical place to clean wheat, preferably as part of the thrashing operation, because the necessary power is available and

later handling is avoided. Since satisfactory cleaning is not always possible under present conditions at thrashing time, other means of cleaning must be used.

The fanning mill is the most practical cleaning machine for farm use, and if properly adjusted and operated will clean wheat satisfactorily for commercial purposes with but little loss of wheat in the screenings. Many types of fanning mills are manufactured that are suitable for cleaning wheat on the farm. One type of fanning mill is shown in Figure 6. The number of sieves used and the pitch at which they are set vary in the different types of fanning mills. Operating directions are furnished by the manufacturer of each type of fanning mill. These are printed on cardboard and usually are attached to the fanning mill. If the directions are followed carefully good results may be obtained. In case the results are not satisfactory it is advisable to send a sample, about 1 quart, of the grain to be cleaned to the manufacturer of the fanning mill, asking for instruc-

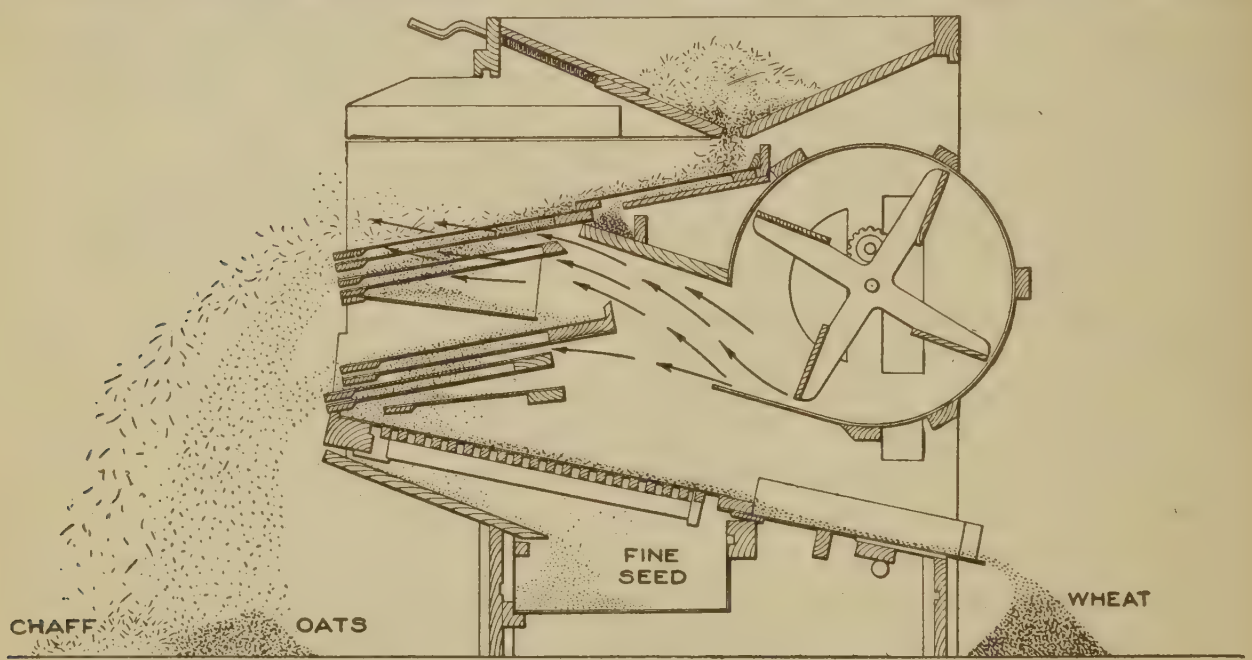

FIG. 6.—Cross section of farm fanning mill in operation.

tions to cover that particular case. If the size of the openings in the sieves furnished is at fault new sieves with the proper sized openings should be purchased. The cost of the additional sieves will be well repaid in the results obtained.

The fanning mill needs to be adjusted closely for best results in cleaning seed wheat. A satisfactory adjustment for cleaning hard red spring wheat for seed is to use a top sieve with perforations just large enough to let the wheat kernels pass through. This will scalp off much of the coarse material, such as wild oats, barley, chaff, and straw joints. The air blast should be adjusted to blow out the dust, many of the wild oats, and light, immature, and diseased wheat kernels that pass through the sieve. The bottom sieve should have perforations large enough to let the weed seeds and cracked wheat pass through. The feed should be so adjusted that the flow of grain will keep the top sieve well filled with wheat. This will cause the coarse material to ride along on top of the wheat and tail over the end of the sieve. If either oats or barley are present in large quantity, it may be necessary to increase the feed to the point of allowing a small quantity of wheat to tail over with the coarse material in order to

insure the removal of a greater percentage of the oats and barley. In cases where there are large quantities of foreign material to be removed from seed wheat it may be necessary to run the wheat through the fanning mill several times to do a perfect job of cleaning.

Durum wheat is more difficult to clean than hard red spring wheat, although it may contain practically the same kinds of weed seeds. Often durum wheat kernels are practically of the same length as the wild oats and barley kernels, so that it is difficult to remove foreign material of this type by screening.

The screenings obtained from cleaning seed wheat often contain some wheat fit for commercial purposes, and by running the screenings through the fanning mill much of this may be reclaimed. However, in many cases the quantity of wheat present in the screenings will not justify the time and expense required for cleaning the screenings. When this is the case the value of the wheat is not lost if the screenings are ground and fed to live stock.

CLEANING WHEAT AT COUNTRY ELEVATORS.

In the central Northwest the country elevator is the first place where a general effort is made to remove the foreign material from commercial wheat. Many of the elevators built in that section during recent years are equipped with machines for cleaning wheat. The older elevators, especially those built more than 20 years ago, as a general rule, are not so equipped. These are generally of a type which requires considerable remodeling before cleaning machines can be installed. In 1920 the Federal Trade Commission found that out of a total of 2,713 country elevators located in the principal spring wheat States, about 39 per cent were equipped for cleaning wheat.[3]

The operators of country elevators are beginning to realize more keenly each year that it pays to clean wheat before shipping it to the terminal markets. Many of the country elevators not only clean wheat for themselves but for the farmers as well. The latter is known as "custom cleaning," for which country elevators located in the central Northwest ordinarily charge from 2 to 3 cents per bushel, based on the gross weight of the grain before cleaning. A higher charge is made for cleaning the grain for seed purposes. The shrinkage in the weight of the grain is borne by the owner, but the screenings may be returned to him. The returns from custom cleaning add a considerable amount to the income of some country elevators during the year. Such cleaning, particularly the cleaning of seed wheat, often can be done during the slack periods of the year.

The cleaning machines installed in the country elevators for general-purpose cleaning use the same principles for removing the foreign material from the wheat as the farm fanning mills. They are usually known as receiving separators and have a much greater capacity than the ordinary sized farm fanning mill. Many of the elevator companies who have to contend with large quantities of cockle, wild peas, and other dockage of like nature find it to their advantage to install special machines in addition to the receiving separators for separating such material from the wheat.

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[3] Report of the Federal Trade Commission on the Grain Trade, vol. 1, Country Grain Marketing, September 15, 1920.

A type of receiving separator is shown in cross-section in Figure 7.

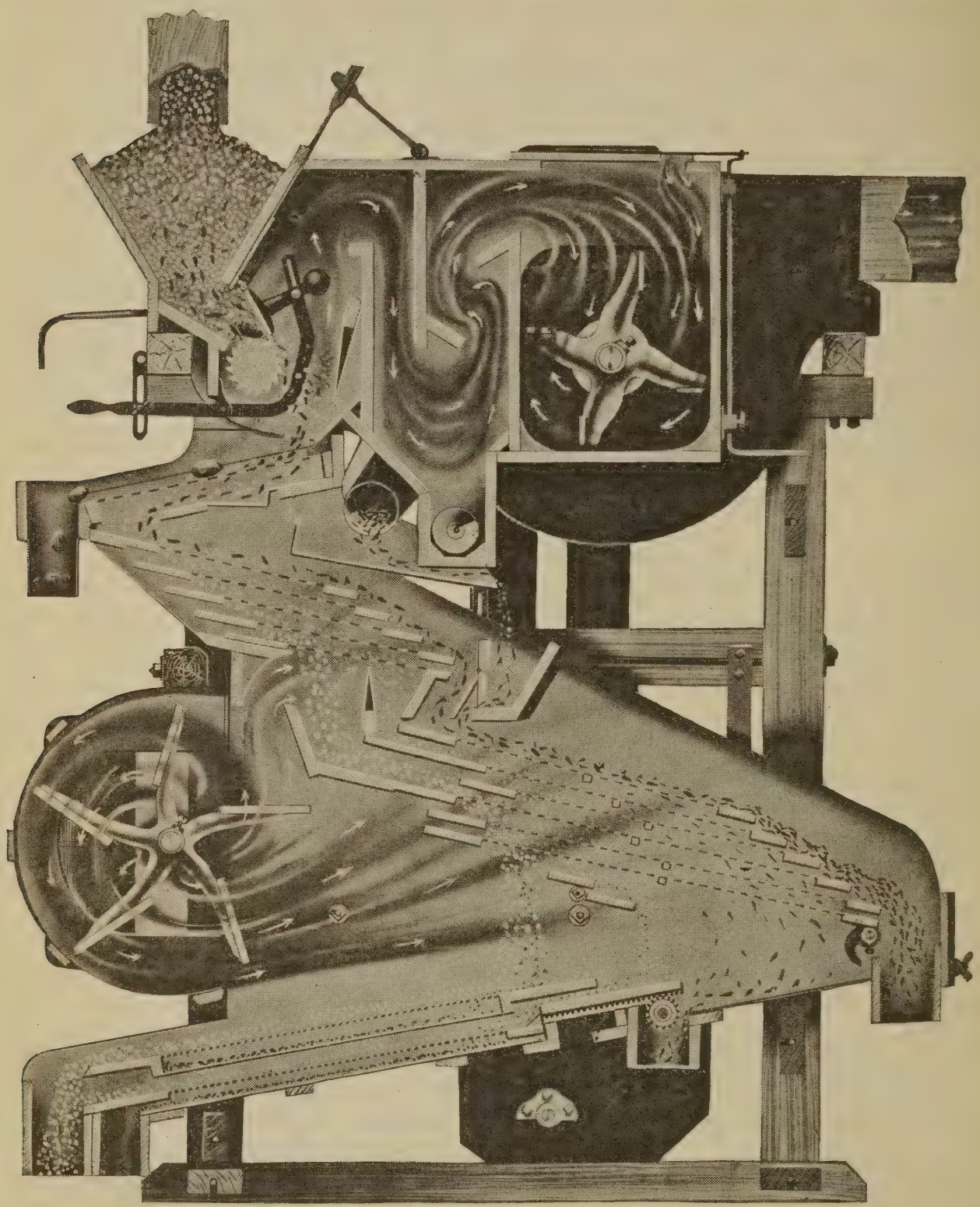


FIG. 7.—A cross section of a receiving separator in operation. This type uses both air blast and air current, and sieves for separating the foreign material from the wheat.

DESCRIPTION AND ADAPTABILITY OF CLEANING MACHINES.

There are many types of machines on the market for cleaning wheat. These may be divided into two general classes according to the different methods they use in separating the foreign material from the wheat. All of the types using sieves and air blasts or air currents may be classed as sieve and air machines, and those using corrugated or indented surfaces, and machines using the principle of sloping smooth surfaces and centrifugal force may be classed as special cleaning machines.

SIEVE AND AIR MACHINES.

Sieve and air machines are constructed so that both sieves and air currents are used to separate the foreign material from the wheat. The majority of the wheat-cleaning machines in common use are of this class. In one type of these machines the sieves shake in the direction the wheat travels. This type is known as an end-shake machine. In another type the sieves shake crosswise of the path the wheat travels and this is called a side-shake machine. The fans in these machines either drive a current of air out through, or draw it in through, the grain as it passes through the cleaning machine. The former is known as air blast and the latter as air suction. Air blast and air suction both are used in a few types of these machines. A machine of this class, equipped with side-shake sieves, air blast, and air suction, is shown on page 14. Various types of sieve perforations are shown in Figure 8.

SPECIAL CLEANING MACHINES.

Special cleaning machines are designed primarily to separate from wheat foreign material of a specific character such as cockle, wild oats, and wild peas. Among the more common machines included in this class are the apron separators, disk separators, cockle cylinders, ring graders, spiral gravity separators, and king-head separators. In almost all cases it is essential for best results to clean the wheat on the general-purpose cleaning machines, such as the fanning mills or receiving separators, before it is cleaned on the special machines.

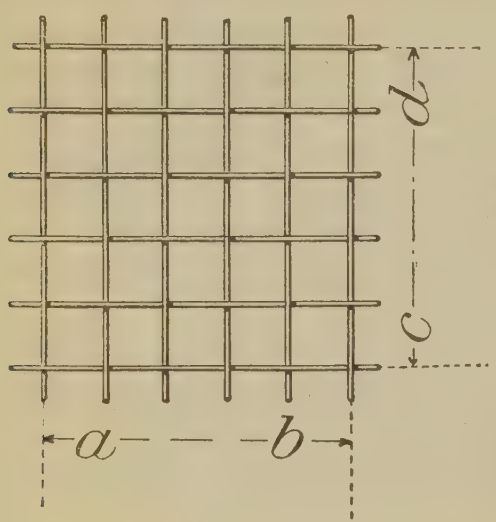
APRON SEPARATORS.

The apron separator has been in use in the spring-wheat States for a number of years. This machine consists primarily of a broad endless metal belt running over two pulleys set about 3 feet apart on an inclined plane. Thus the belt forms an apron which travels continuously up a slight grade. The apron has indentations on the outer side large enough to hold wheat kernels but too small to hold wild oats or other seeds of like nature. Brushes, which sweep its surface, operate diagonally over and near the upper end of the apron. The grain is fed onto the apron in a thin stream near the lower end of the apron. The wheat kernels fall into the indentations, pass under the brushes, and leave the apron as it passes around the upper pulley. The wild oats and other coarse material are swept to the side of the apron, where they are discharged from the machine. A sieve is placed in the bottom of the machine, which removes almost all of the small weed seeds from the wheat. If too heavy a feed is applied to this machine some of the wheat will be brushed off the apron along with the coarse foreign material.

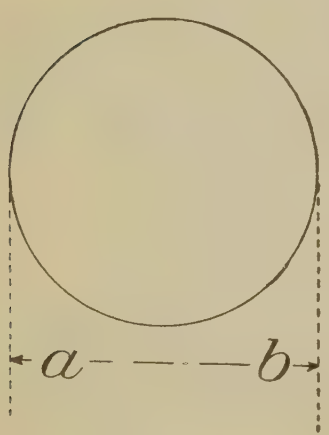
DISK SEPARATORS.

The disk separator is shown in Figure 9. This separator consists primarily of a number of disks set about $2\frac{1}{2}$ inches apart on a shaft which is placed in a horizontal position. The outer 6 inches of the disks are solid and have small cuplike pockets in either side. These pockets

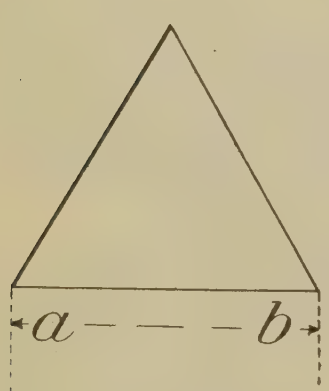
vary in size for the different disks, ranging from very small ones to pockets the size of a wheat kernel. The disks with the smallest pock-



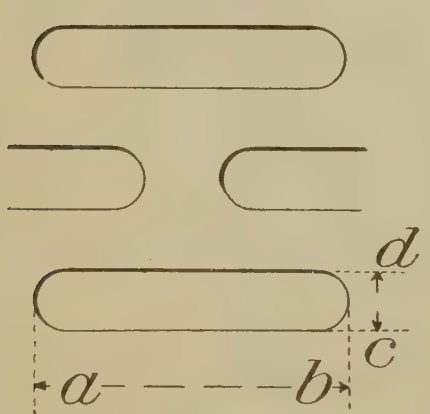
Wire mesh. Measure 1 inch along *ab* and count the number of openings, then measure 1 inch along *cd* and count the number of openings.



Round hole perforation. Measure the diameter the greatest distance across the opening.



Triangular buckwheat. Measure along any one of the three sides of the opening.



Oblong or chess. Measure the length of the opening from *a* to *b* and across the opening from *c* to *d*.

FIG. 8.—Diagram showing wire mesh and the different types of perforations in grain sieves.

ets are placed next to the head end of the shaft; the next size follows this one, and so on until the disks are all placed. The solid portions

of the disks are supported from the shaft by spokes so shaped that they keep the grain moving forward through the machine. The disks are inclosed in a steel case which is kept about one-third full of grain when the machine is operating. The grain is fed into the machine near the head end, and as it moves forward through the machine the various types of foreign material present are separated. The small weed seeds are picked up in the pockets on the first disks and

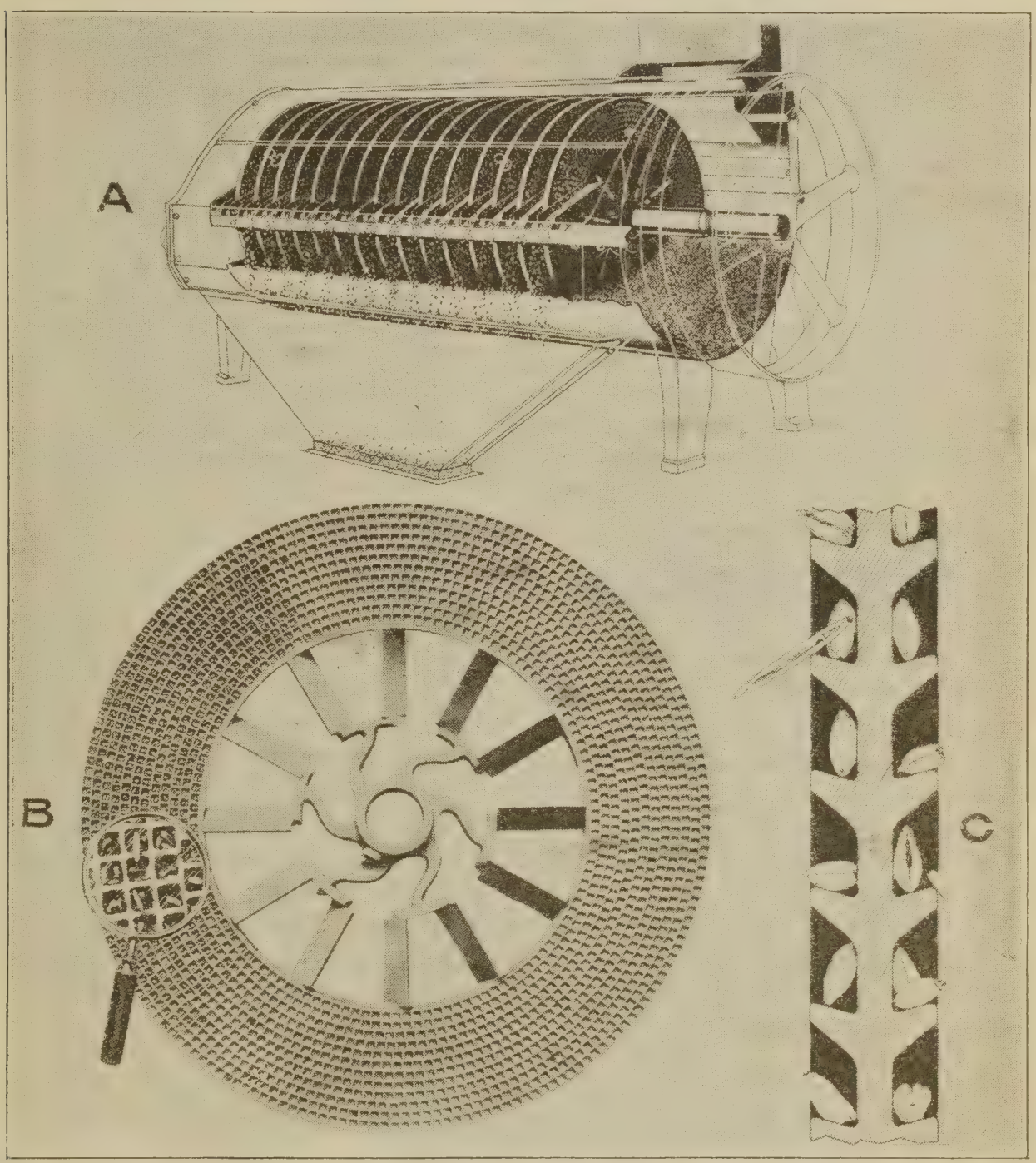


FIG. 9.—Disk separator. (*a*) Phantom view of the machine in operation; (*b*) side view of one disk; (*c*) cross section of a disk showing how oats and other coarse foreign material are separated from wheat.

are discharged into a trough and carried from the machine by gravity. The larger seeds and wheat pass along until they encounter the disks with the next larger-sized pockets which pick up the wheat. No pockets on the disks are made large enough to pick up oats and other coarse material, and such material is discharged through a separate spout at the tail end of the machine. The disk separator has proved efficient in the removal of almost all types of foreign material from

wheat. It occupies small floor space and in operation requires little or no adjustment and a small amount of attention.

COCKLE CYLINDERS.

Cockle cylinders are used for removing cockle and wild peas from wheat. These cylinders ordinarily are about 20 inches in diameter, 5 feet in length, and revolve about a stationary shaft set on an incline. The inside wall of the cylinder, Figure 10, has round indentations slightly smaller in diameter than the size of a wheat kernel. The grain is fed into the upper end of the cylinder. The cockle, small pieces of wheat kernels, and other small seeds fall into the indentations and are carried near the top of the cylinder as it rotates. This material then falls out of the indentations into a trough which is supported from the shaft of the cylinder. As the indentations are too shallow to support the wheat kernels as readily as the cockle seed, the wheat rolls down the sides of the cylinder in time to escape falling into the trough. The wheat travels slowly toward the point of discharge at the lower end of the cylinder, continually coming in contact with indentations. The capacity of a single cockle cylinder is small. To obtain greater capacity, the cylinders are arranged in pairs, or grouped in larger numbers, as shown in Figure 11.

RING GRADERS.

The ring grader consists of a cylinder made up of a large number of narrow rings. The cylinder is placed in a slightly inclined position and the rings are spaced on the shaft the proper distance apart to make the desired separations. The spaces between the rings increase from the upper to the lower end of the cylinder. The grain enters at the upper end of the cylinder, and as it passes toward the lower end the separations are made. The coarse foreign material is discharged through an opening at the lower end of the cylinder. In most cases the rings may be adjusted so that the openings between them are suitable for separating different kinds of grain or the same grain according to the size of the kernels. Ring graders are not used to any great extent in this country, but they are used extensively in some of the foreign countries for grading grain according to the size of the kernels.

SPIRAL GRAVITY SEPARATOR.

The spiral gravity separator requires no power, little attention, and small floor space. It is particularly useful for recleaning screenings or mixtures containing mustard, vetch, turnip, rape, wild peas, or other seeds spherical in shape. When such mixtures have had a preliminary cleaning to remove all the coarse trash and light dust, the spiral, by a combination of gravity and centrifugal force, makes a satisfactory separation of the round seeds.

The grain enters at the top of the spiral and gathers momentum as it flows toward the bottom. As the round seeds roll more readily than the semiround ones, they roll nearer the outer edge, and flow in a stream near the bottom of the spiral. The less rounded seeds are not carried so far from the center and the angular seeds stay still

closer to the center of the spiral. Thus, each kind of seed flows in a separate stream and falls into a different spout at the base of the

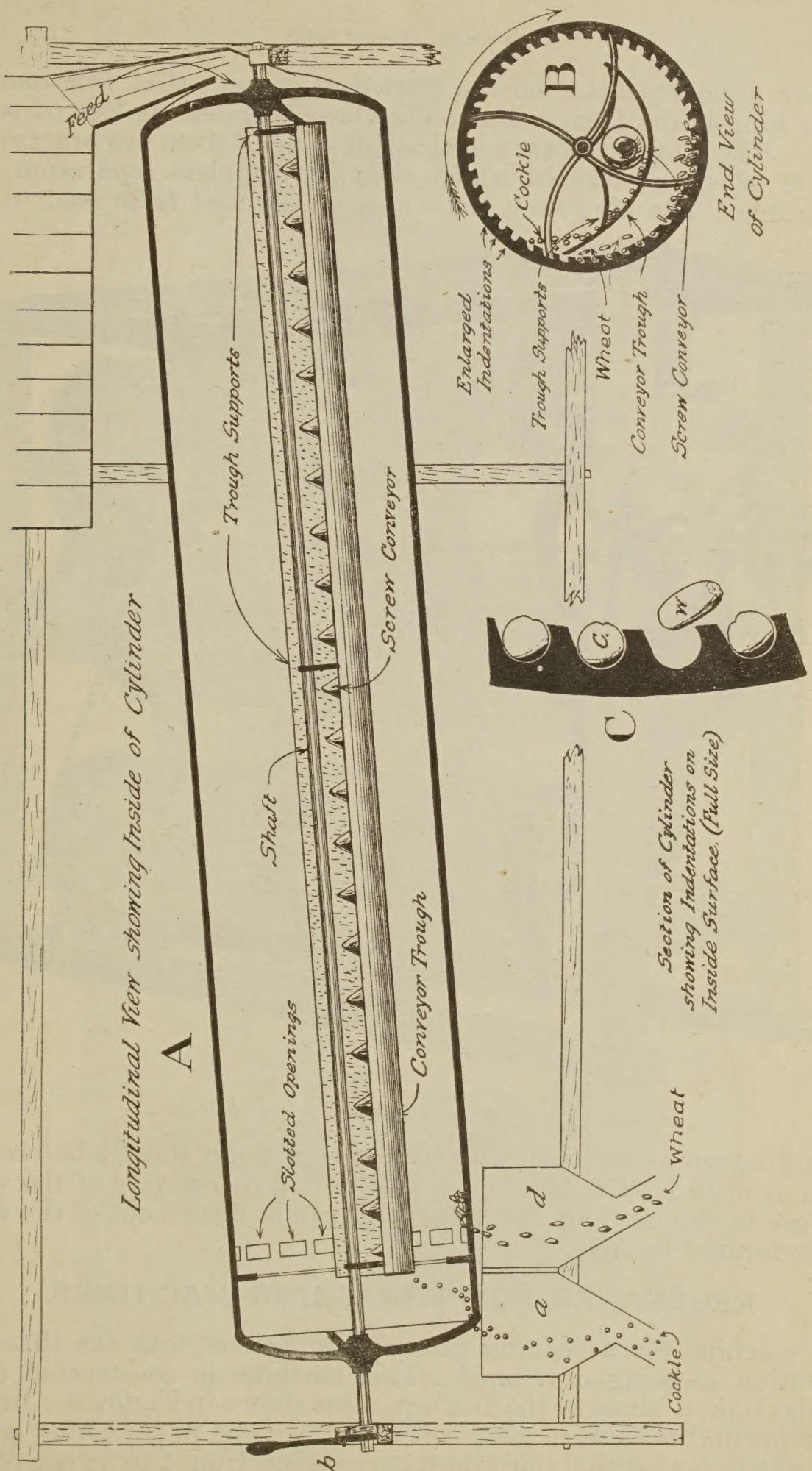


FIG. 10.—Sectional view of cockle cylinder in operation.

spiral. The spiral gravity separators vary in size. They are usually about 6 feet in height and $2\frac{1}{2}$ feet in diameter. The capacity of the

single spiral is small, about 5 bushels per hour. A spiral gravity separator is shown in Figure 12.

KING-HEAD SEPARATORS.

There is no separator on the market at present that will remove all the king-heads from commercial wheat without the loss of some wheat. The king-heads vary in size, but some of them are practically the size of wheat kernels, which makes a complete separation impracticable. The king-head seeds may be removed from seed wheat

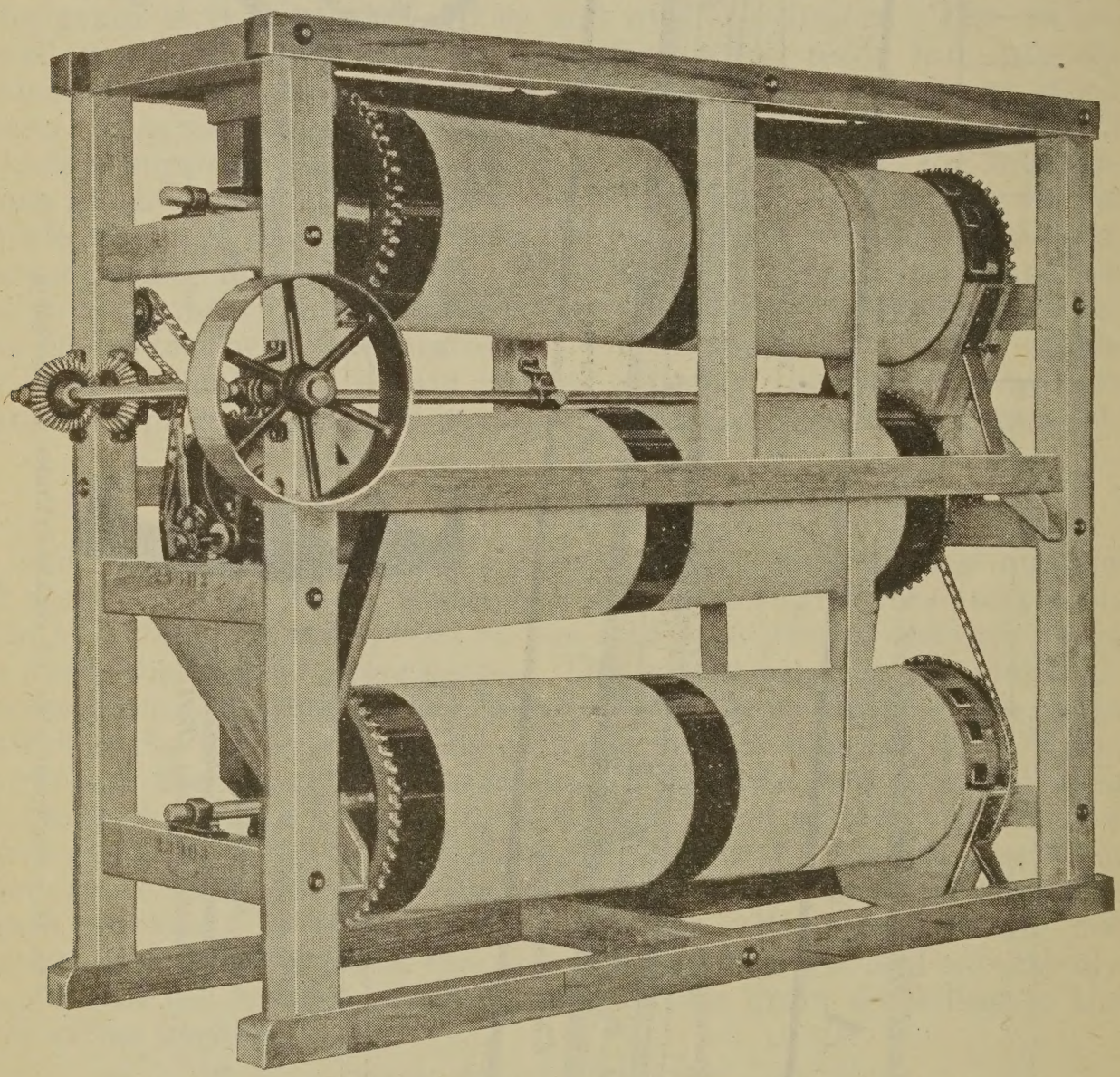


FIG. 11.—Cockle cylinders grouped three high.

or milling wheat by immersing the grain in water shortly before it is sown or milled. The king-heads will rise to the surface of the water and can be skimmed off, then the wheat can be drawn out of the water in perforated buckets.

RECLEANER FOR THRASHING MACHINES.

A machine for recleaning grain in connection with the thrashing operation is being developed. This machine is constructed along similar lines to those of the disk separator shown in Figure 9. In 1921, experimental tests were made with this machine in thrashing several lots of wheat that contained dockage ranging from 1 to 38 per cent in the different lots. The dockage in each lot of wheat was reduced to less than 1 per cent and the screenings removed contained less

wheat than is found ordinarily in elevator screenings. The results from these tests were so satisfactory that further experiments are

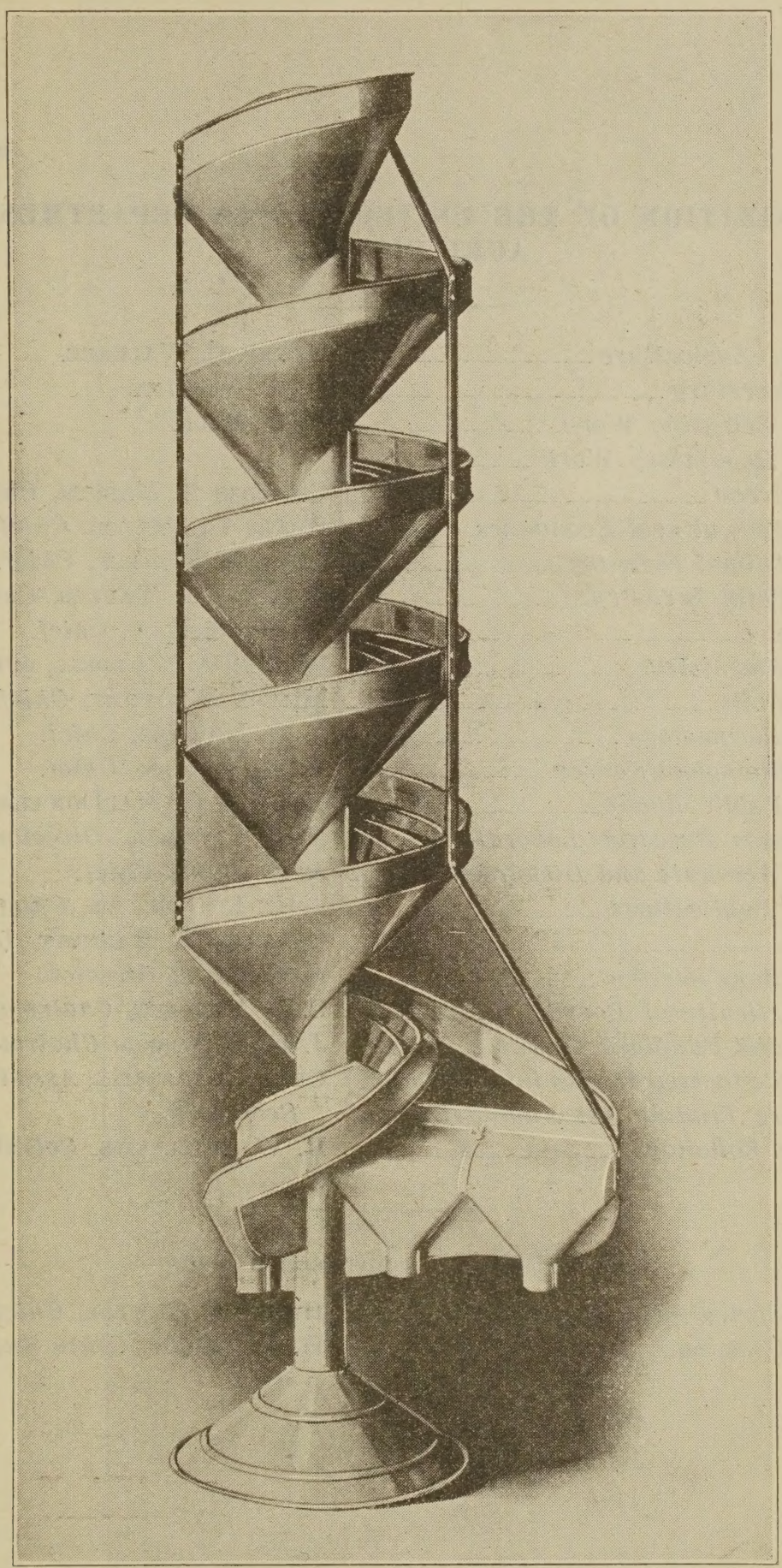


FIG. 12.—Spiral gravity separator in position for operating.

being conducted to improve its design and to determine whether or not it is practicable to adapt this machine for use on all sizes and makes of thrashing machines.

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